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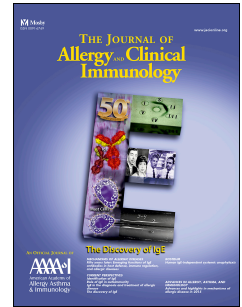
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Accepted Manuscript

Distribution of Peanut Protein in School and Home Environments of Inner-City Children

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Title: Distribution of Peanut Protein in School and Home Environments of Inner-City Children

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Word count: 1,021

Capsule Summary:

Peanut protein was widely detectable in dust samples from school classrooms and cafeterias, with school levels higher than home levels, suggesting that schools may be an important place of exposure to food allergens in the environment.

Keywords:

Peanut, Food Allergy, Schools, Environment, Dust, Inner-City, Children

To the Editor:

Recent research on peanut allergy development has focused on the importance of exposure to peanut protein in the environment. Peanut protein has been detected in vacuumed dust from homes of young children.¹ Furthermore, early life exposure to peanut in household dust has been associated with an exposure-response increased risk of peanut sensitization that is more pronounced in children with eczema or filaggrin gene mutations.^{2,3} These studies have focused on home environments; however, little is known about peanut protein in school environments where children spend a great amount of time. This study evaluates the distribution of peanut protein in school environments and compares these findings with levels in corresponding homes of students.

The parent trial for this study was the School Inner City Asthma Study, a comprehensive evaluation of the impact of school-specific allergen exposures on student's asthma while adjusting for home allergen exposures.⁴ The enrolled participants were children with asthma, aged 4-13 years, attending inner-city public schools in northeastern United States from 2008-2013. All schools in the study allowed students to bring and eat peanut-containing foods. Written informed consent was obtained from enrolled participants. The protocol was approved by the local institutional review board and the schools.

For environmental assessment in the study, settled dust from the school cafeterias and classrooms were collected during the academic year. School dust samples were obtained by research personnel using an Oreck XL (model BB870-AD) hand-held vacuum with a special dust collector (DACI lab, Johns Hopkins, Baltimore,

MD) fitted into the inlet hose using a standardized protocol.⁵ Vacuum sampling was performed in schools as previously described and demonstrated.^{4,6} In accordance with the protocol of the larger parent trial, one dust sample was also collected in the student participant's bedroom utilizing a standardized protocol.⁷ To provide comparison groups for this smaller study, samples to be analyzed for peanut protein were randomly chosen from the following known groups: (1) school classrooms, (2) school cafeterias, (3) homes of subjects without peanut allergy, and (4) homes of subjects with peanut allergy.

Dust samples were sieved and the fine dust was extracted as previously described.⁸ Peanut protein in the dust was quantified using the Veratox polyclonal ELISA (Neogen, Lansing, MI) against whole peanut protein which has a lower limit of quantification (LLQ) of 0.5 micrograms per gram of dust ($\mu\text{g/g}$). This method of analyzing whole peanut protein has been validated in measuring the amount of whole peanut protein in foods, dust, and wipe samples.⁸ Researchers performing the ELISA were blinded to the location source of the dust samples. Comparisons between the independent groups were made using the Wilcoxon rank-sum test. Statistical computations were performed using SPSS (23.0) software (IBM Corp., Armonk, NY). All tests were two-tailed and alpha was set at 0.05.

In total, 146 vacuumed dust samples were analyzed for the presence of whole peanut protein including 87 samples from 18 schools and 59 samples from 59 homes of students attending those schools. Of the school samples, 100% had detectable peanut protein with a median value of 45.3 $\mu\text{g/g}$ (range 1.4 – 468.0 $\mu\text{g/g}$). There was no difference in the levels of peanut protein from the 26 samples analyzed from cafeteria

collected dust as compared to the 61 samples analyzed from classroom collected dust (median 39.1 $\mu\text{g/g}$ vs. 46.3 $\mu\text{g/g}$, $p=0.941$, Figure 1).

In the students' homes, 97% of the bedroom vacuumed dust samples had detectable peanut protein with a median value of 25.2 $\mu\text{g/g}$ (range <LLQ – 404.3 $\mu\text{g/g}$). The 16 dust samples from homes of students with peanut allergy had significantly less peanut protein as compared to the 43 samples from homes of students without peanut allergy (median 4.0 $\mu\text{g/g}$ vs. 29.2 $\mu\text{g/g}$, $p=0.005$).

Peanut dust levels in school samples were higher than peanut dust levels in home samples overall (median 45.3 $\mu\text{g/g}$ vs. 25.2 $\mu\text{g/g}$, $p<0.001$) and also when individually comparing only cafeteria dust samples or only classroom dust samples to home dust samples as seen in Figure 1. After excluding samples from the homes of peanut allergic children, the difference in peanut protein between schools and homes of children without peanut allergy did not reach statistical significance (median 45.3 $\mu\text{g/g}$ vs. 29.2 $\mu\text{g/g}$, $p=0.075$); this is likely due to small sample size as peanut levels were still over 50% greater in schools.

These findings demonstrate that peanut protein was widely detectable in dust samples obtained from both classrooms and cafeterias of schools, with peanut in school dust higher than levels in students' homes. This suggests that schools may play an important role in exposure to environmental peanut allergens.

Within the schools, it was not unexpected to find peanut protein in the samples collected from cafeterias; however, it was surprising that peanut was detectable in similar levels in the classrooms. All of the evaluated schools had cafeterias where all meals were eaten. While snacks may have been eaten in classrooms, it is also

possible that peanut protein was transferred within the school on hands, clothing, or shoes. It has been documented that peanut protein can be resistant to usual cleaning methods, thus being easy to spread in the environment.⁸

It was interesting that peanut levels in the schools were significantly higher than in homes. This may be expected when comparing school cafeterias to home bedrooms; however, we also found that peanut levels in classroom dust were higher than levels in bedrooms; two locations where meals would not be regularly eaten. The levels of peanut protein detected in our schools were at least comparable, if not greater than, previously reported levels in infant's bedrooms and play-areas from homes in the United Kingdom.^{1,8} Perry et al. reported that peanut allergen Ara h 1, *Arachis hypogaea* allergen 1, was not widely detectable in schools by monoclonal ELISA testing.⁹ Our study did not measure individual peanut allergens, but instead evaluated for the presence of whole peanut protein via a polyclonal peanut ELISA that has previously been associated with clinical outcomes in children with atopic dermatitis or filaggrin gene mutations.^{2,3} Given the previous findings in homes, we speculate that the environmental peanut exposure in schools may also be important for at risk children. Further evaluation of the clinical implications of these school-based exposures is warranted.

Figure 1 Legend:

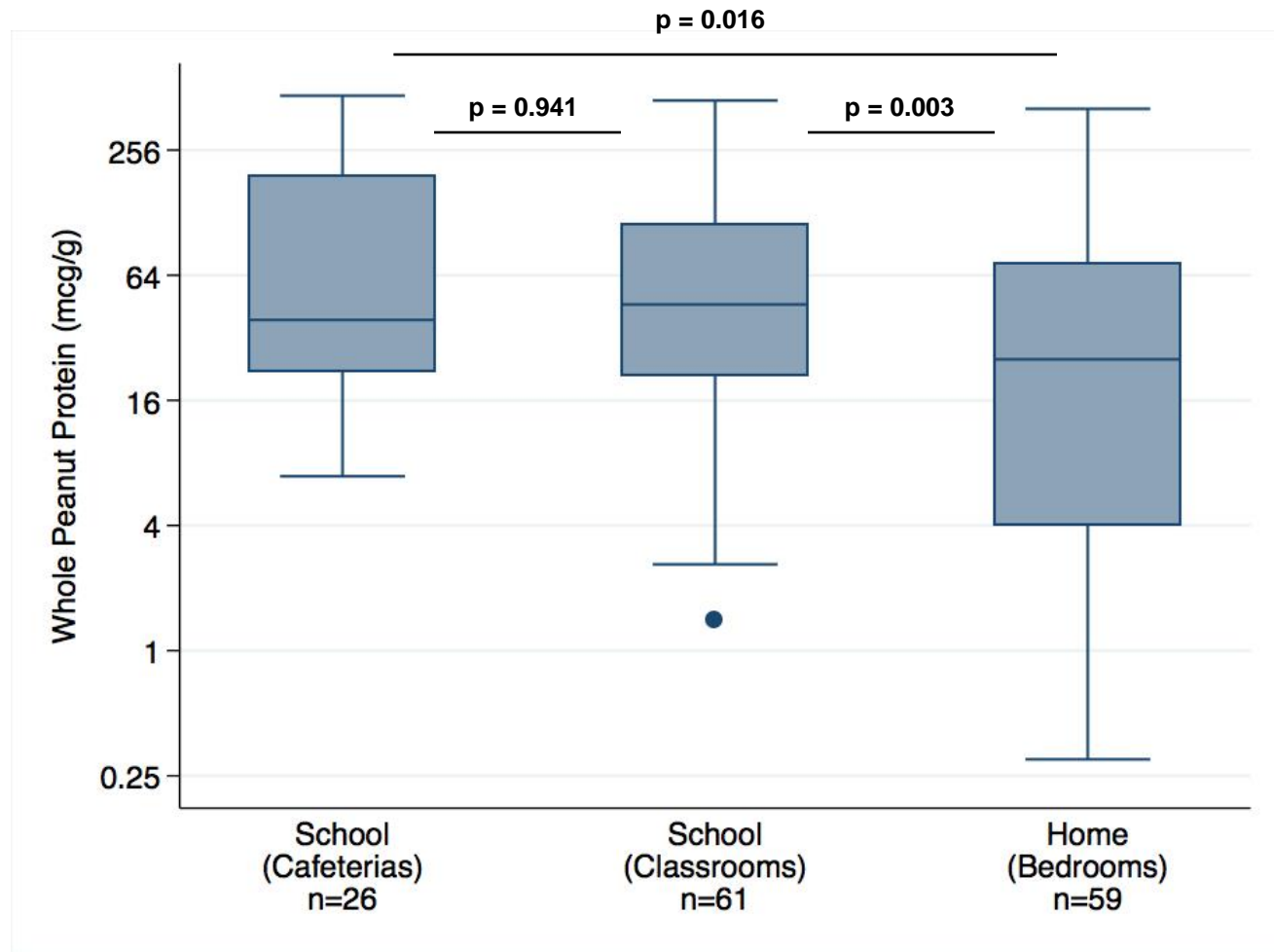
Whole Peanut Protein Detected from Vacuumed Dust Samples in Schools and

Homes. Data from homes include a combination of homes of children with and without peanut allergy. Further delineation of these 59 homes demonstrates that samples from the 16 homes of students with peanut allergy had significantly less peanut protein as compared to the samples from the 43 homes of students without peanut allergy (median 4.0 $\mu\text{g/g}$ vs. 29.2 $\mu\text{g/g}$, $p=0.005$).

REFERENCES:

1. Brough HA, Santos A, Makinson K, Penagos M, Stephens AC, Fox AT, et al. Peanut protein in household dust is related to household peanut consumption and is biologically active. *J Allergy Clin Immunol* 2013;132:630-8.
2. Brough HA, Simpson A, Makinson K, Sara B, Douiri A, Belgrave D, et al. Peanut allergy: impact of environmental peanut exposure in children with filaggrin loss-of-function mutations. *J Allergy Clin Immunol* 2014;134:867-75.
3. Brough HA, Liu AH, Sicherer S, Makinson K, Douiri A, Brown SJ, et al. Atopic dermatitis increases the effect of exposure to peanut antigen in dust on peanut sensitization and likely peanut allergy. *J Allergy Clin Immunol* 2015;135:164-70.
4. Phipatanakul W, Bailey A, Hoffman EB, Sheehan WJ, Lane JP, Baxi S, et al. The school inner-city asthma study: design, methods, and lessons learned. *J Asthma* 2011; 48:1007-14.
5. Mitchell H, Senturia Y, Gergen P, Baker D, Joseph C, McNiff-Mortimer K, et al. Design and methods of the National Cooperative Inner-City Asthma Study. *Pediatr Pulmonol* 1997;24:237-52.
6. Smedje G, Norbäck D, Edling C. Asthma among secondary schoolchildren in relation to the school environment. *Clin Exp Allergy* 1997;27:1270-8.
7. Arbes SJ, Sever M, Vaughn B, Mehta J, Lynch JT, Mitchell H, et al. Feasibility of using subject-collected dust samples in epidemiologic and clinical studies of indoor allergens. *Environ Health Perspect* 2005;113:665-9.

- 161 8. Brough HA, Makinson K, Penagos M, Maleki SJ, Cheng H, Stephens AC, et al.
162 Distribution of peanut protein in the home environment. J Allergy Clin Immunol
163 2013;132:623-9.
- 164 9. Perry TT, Conover-Walker MK, Pomés A, Chapman MD, Wood RA. Distribution of
165 peanut allergen in the environment. J Allergy Clin Immunol 2004;113:973-6.



p values = Wilcoxon rank-sum test